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Transurbanism: Smart Cities for Transhumans

Mattia Thibault[1], **Oğuz 'Oz' Buruk**[1], **Seda Suman Buruk**[2], **Juho Hamari**[1]
[1] Gamification Group, Tampere University, Tampere, Finland
[2] Independent Urban Designer, Tampere, Finland
mattia.thibault@tuni.fi, oguz.buruk@tuni.fi, sedasuman@gmail.com, juho.hamari@tuni.fi

ABSTRACT
The current trends related to 'smart cities' are bringing the cityscapes of movies such as *Blade Runner* and games such as *Cyberpunk 2077* closer to our immediate reality. The question of what will the cities of the future look like is at the heart of urban studies. In parallel, a similar question is posed by (trans)humanists about the future of humanity and its possible technological enhancements. However, (trans)humanity and future cities are defined in a bi-directional dependency. Therefore, we have to answer the questions of future humans and cities simultaneously. This paper maps several ways of interacting between transhuman communities and smart cities to understand their possible effects on governing, design and society at large resulting in a framework and a series of speculative pastiche scenarios that will work as a cautionary tale and an inspirational blueprint for imagining future urbanity.

CCS Concepts
•Human-centered computing → HCI theory, concepts and models; User models; Interaction design theory, concepts and paradigms; Ubiquitous and mobile computing theory, concepts and paradigms;

Author Keywords
Smart Cities; Transhumanism; Design Fiction; Design Speculation; Transurban design; Urban Design; Pastiche scenarios

INTRODUCTION
What will the cities of the future look like? This question is often at the heart of urban studies, especially those dealing with smart cities, government or sustainability. Transhumanists ask a different question: What will the human beings of the future look like? Or in other words, how will the integration of technologies with the human body and cognition change them and maybe transform them into something more?

Transurbanism is based on the realisation that we cannot answer one of these questions without the other. Citizens and cities make each others. Citizens shape the urban environment around them, they build and destroy, try to engrave their identities, ideas and beliefs in the urban fabric. Cities, on the other end, are matrices that shape their inhabitants, they make them "urban", "polite" and "civilised" (all words from Greek and Latin roots for "city"). We cannot, therefore, imagine a future city without imagining also its future citizens and vice versa. Transurbanism studies how transhuman inhabitants interact with an augmented built environment.

This paper proposes a framework for *transurbanism*: a bridge between transhumanism and smart cities. Transhuman studies focus on how the inclusion of technologies in the human body will radically change our lives and, ultimately, what it means to be human [61]. Smart cities, on the other hand, investigate how the implementation of connectivity and big data technologies in the urban fabric can make cities more responsive, adaptable and sustainable [12]. Transurbanism is not merely the combination of the two, but it is an attempt to imagine applications of *more-than-human design* in the urban environment [13, 24, 23]. In this paper we focus especially on transhuman citizens, seen as the next step for a humanity composed of *prosthetic creatures* [88]. Therefore we try to envision a future transurban life, built on technologies we cannot yet fully understand or control, and to outline some of its opportunities and challenges.

The relationships between technologically enhanced humans and the urban environment have been at the centre of research efforts in the past. Virilio [85] claimed that technology would blur the boundaries between the city and the individual, so that we will no longer talk of the *body in the city* but of the *city in the body*. While many works focus on allegorical cyborgs [29], others [66] focus on the experience of urban environment by people identifying as cyborgs. However, there is scant evidence of city-making practices led by a transhuman-centred approach.

What does it specifically entail forming a bridge between transhumanism and smart cities? Broadly, transhumanists envision a seamless integration of technologies in the human body which will confer to humanity abilities that today are beyond our reach. Bostrom articulates these enhancements as bodily abilities (longer life span, physical and sensory enhancement), cognitive skills and emotional states. As there are no limitations to the nature of these enhancements, our framework will encompass in the realm of possibilities also those that might appear bizarre and disturbing (such as the antenna that Neil Harbisson has implanted in his skull and that allows him to "feel" colours and even to "receive" them from the internet). On the other hand, research on smart cities generally focuses on the impact of information technologies on urban spaces, citizens, city life, infrastructure, management and design. The two fields, then, are closer than they look, as we have, on the one hand, enhanced humans, and on the other hand, an enhanced anthropic environment. Our intention here is to highlight the possible intersections between these two spheres by mapping

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several modes of interaction between transhuman abilities and smart city layers which are design, management and society.

Our methodology is grounded in speculative design: a well-established practice that uses design as a form of critique and speculation within disciplinary, scientific and societal frames [52, 19, 75]. In particular, we combine this approach with notions of urban design, in order to create a framework of possible interactions between smart cities and transhuman citizens. We then focus on three *pastiche scenarios* [5, 28] of transurban interactions (based on emotional mapping, transurban mobility and the Internet of Citizens), each examined both by a utopian and a dystopian perspective, based on different technosocial possibilities. The results work both as a cautionary tale and as an inspirational blueprint for imagining future cities and anticipating the issues and possibilities offered by transhuman technologies.

NEW URBAN PARADIGMS AND TRANSHUMAN CITIZENS

Reshaping Urban Spaces

There has always been a dynamic relationship between technology, cities and how they are designed. Industrialisation, for example, caused a population explosion in urban areas [58] which in turn raised social, economic and spatial challenges: the emergence of slums, an increase of social class differences, vehicles congestion, etc. When new technologies are integrated into daily life, they also disrupt urban and architectural practices. Automobiles increased mobility and accessibility causing changes in land-use planning, reconfiguring street widths, creating new design paradigms for public spaces and extending the scale of the cities. With the increased speed, a loss of aesthetic concerns ultimately caused the disappearance of the elaborated door frames, stoops or window sills [70]. The elevator rendered skyscrapers possible planting the roots of vertical cities [49, 17]. Technologies that change the way citizens experience the city have a profound impact on city making practices. New technologies always bring new challenges to their time and thereby, it is critical to understand their different dimensions.

Today, cities are facing great transformations due to the challenges of globalisation and of the ICT revolution. On the one hand, economic globalisation as well as migration tend to blur identities and reshape neighbourhoods, rewriting the urban fabric and, sometimes, erasing almost completely the older layers [16]. The outsourcing of industrial production far from Western cities has left behind a series of *terrain vagues* that cities are trying with patience to refunctionalise and re-insert into the urban. The most immediate reaction to these paradigm changes, have often been to resort to old values: cities have been reshaped according to census (what we call "gentrification"), to ethnicity (the rhetoric "Londonistans") or both (like in Paris' *banlieues*). On the other hand, Internet and ICT revolution also had an enormous impact on cities [10], in particular eroding their meaning. Many tasks that used to require physical movement can be done remotely, with an Internet connection. The spaces of the city lose part of their traditional meanings while their use value slowly disappears.

A partial solution has been proposed by the advocates of smart cities. Smart technology, they claim, will contribute to the cities in terms of functionality, but has also the potential to address issues of sustainability and efficiency. Continuous monitoring, geo-tracking and ubiquitous computing can offer tools for engaging citizens, influencing their behaviour and measuring its impact on the city [53]. The ability of gathering and processing big data is becoming a cardinal asset for urban design where data-driven decision making is likely to become the norm [21]. These technologies, however, are not neutral: they raise many concerns regarding privacy, instrumentalist urban planning and technological lock-in [83, 46] and regarding the potential profits emerging from these practices, and what new economic models should be created around them [56]. There are also many doubts in terms of how and by whom all this information should be collected, for what purposes it could and should be used and finally who should have control over it. City planning, nevertheless, cannot be scaled down to a process of data collection [56]: cities are a versatile, constantly changing and transforming mechanism, reproducing and living through a multitude of relationships. Therefore, although urban data processing can indeed provide information that was not accessible before, it would be useless without understanding the interactions between citizens and the city through this data producing technologies. From an ethical standpoint it is clear that an expansion of citizens' *rights to the city* is needed to take into account its digital layers. The possibility of the citizens to reuse or profit from their data or to prevent completely to be tracked by the authorities are indeed rights of the digital city that should be recognised [26].

Smart cities have also been accused of technocentrism, and the "Playable City" has been suggested as an alternative [63]. Building on strategies of gamification [41, 80] and on the importance of play in urban spaces [76, 27], many recent urbanistic approaches focus on playful ways of involving citizens in city-making so to ensure their right to the city [50]. For example participatory design [34] and "DIY urbanism" [18] aim respectively to involve residents in urbanistic projects and to reshape city spaces through grassroots, bottom-up actions [67]. Games themselves are being used to study urban design (e.g City Skylines) when not to design cities collaboratively altogether [79].

We believe that the concerns towards smart cities raised by the aforementioned scholars are relevant and deserve to be addressed by any take on the future of cities. While we believe that technological change in urban spaces is, at least in some measure, inevitable, we also think that it is the role of academia to try to outline both the benefits and the risks deriving from their implementation. Therefore, challenges as well as the opportunities of implementing new technologies should be elaborately examined while creating new design paradigms.

Transhumanist Futures and Transurbanist Reflections

In its broadest definition, the transhumanist paradigm indicates the next possible step in the evolution of human beings is through the bodily integration of technology [7]. Transhumanism claims that humans will be able to reach an enhanced state of being through advanced technologies that will improve their physical abilities, cognitive abilities and emotional abilities [7, 6, 72]. In this section, we explore some of the potential progression related to these three pillars of transhumanism and start to reflect on how these changes might affect urban design, city-governing and society.

The physical abilities of the human body are subject to great changes in a transhumanist future in which the body, sensory abilities and life span of humans are enhanced. The technological

advances in bionic replacements for amputees, for example, have already reached a point in which the artificial limb is allegedly better than the original one in some capacity - this is the case of the running blades of notorious Olympic runner Oscar Pistorius [73]. While it still conveys a quite cyberpunk sci-fi flavour, it is not impossible to imagine a future where humans replace or improve their limbs so that they might be more durable, stronger or augmented with novel capabilities, and become cyborgs [37, 35]. In a transhumanist future, humans might be able to walk or run all-day with little to no fatigue. With the implementation of new body parts, they may jump to extreme heights, climb easily on vertical passageways or even fly (if flying humans might indeed feel like an unlikely scenario, we must note the proliferation of "drone multicopters" shows, at least, a continuing interest in this possibility [78]). Future cities, then, will have to afford new forms of mobility. Accessibility will not be an issue anymore (at least in an idealistic transhumanist future in which all enhancements will be available to all and not only to the wealthier) as disabled citizens will be able to replace their body parts to render themselves abled. Personal mobility will change dramatically: humans might travel fast within the city without needing vehicles. At the same time, they may need power stations scattered throughout the city to recharge their artificial implants every now and then. As mobility is a cardinal aspect of cities, it is difficult even to fathom how such technologies will impact urban design paradigms, traffic regulations, logistics, tourism and many other aspects of urban life.

Transhumanism is not only about the enhancement of the body, but also of the mind. In the future, cognitive enhancements might increase dramatically the "processing power" of our brains with brain augmentation processes, including uploading our minds to computers altogether [6, 86]. Brain implants could extend our memory capacity [72, 69], increase our reflexes and even allow our minds to be connected to a mutual repository that will allow us to reach any kinds of information very quickly, similarly to today's cloud systems, a sort of "Internet of Minds" [89]. The augmentation and digitisation of minds will also entail many risks related to privacy, security, hacking and raise several ethical questions regrading conservation, use, replication of such data. The semiotic complexity of urban spaces, seen through this enhanced and connected cognition, will give birth to a continuous kaleidoscopic explosion of interpretations. Citizens will have at their disposal an endless amount of data related to the cityscapes in front of their eyes: of its history, architecture and art, but also memories of other people of the same places, collections of images, trivia and much more. Making sense of urban environments will become a much more elaborate activity since the assessment about cityscapes will include all sorts of knowledge. In that sense, how will transhuman citizens shape the design of the cities? What will they expect from a cityscape in terms of sensory experiences such as visual scenery, soundscape or cultural heritage? How can abuse of this communicative level affect our ways of making sense of the urban spaces? What should cities offer to these citizens when it comes to social and cultural activities?

As Bostrom argues, when the physical and the cognitive abilities of humans are fostered, also their emotions will inevitably change [6]: transhumans will experience emotions that do not exist today. They are also likely to experience less negative emotions due to emotion stabilisation technologies with all the positive sides on mental health and the risks of repression that such an operation entails. Furthermore, transhumans will leave traces of such emotions, as sensors scattered throughout their bodies will produce knowledge about the bodily reflections of their emotional states (adrenaline and endorphin levels, heartbeat, stress, blood pressure etc.). The citizens of the future, then, will not only interact with their cities in novel ways and understand and experience them differently, but the results of these interactions will leave traces. If already today emotions evoked by today's cities were also used to understand how citizens react to specific urban environments [39, 92], in a transhuman future this sort of emotional mapping could be continuous and always openly available. How will this data be employed or what will it be exploited for? Can this data facilitate transhuman citizens to participate in city-making in a more effective way?

Bostrom's categorisation of transhuman enhancements has been useful to reflect on why a transhumanist future will influence how cities will be designed and governed. Nevertheless there is another aspect that should be taken into consideration: the profound impact that these technologies will have on our social constructs and norms. Some central contributions on these aspects come from a rather different tradition than Bostrom's, namely from feminist posthumanism and accelerationism. While focusing more on the ideas of "cyborg", of "hybridisation" and "alienation" such works offer a valuable complementary perspective to our framework. Donna Haraway's *Cyborg Manifesto* [36] for example, shows how the idea of hybridisation and chimerism implicit in the intertwining of bodies and technology, could lead humanity beyond the dualistic understanding of themselves and the world (mind/body, culture/nature, male/female). Bodies are, according to Haraway, always maps of power and identity, and the cyborg body is without gender, at the same time organism and machine and therefore able to completely revolutionise our culture and society. Similarly, the *Xenofeminism Manifesto* by Laboria Cuboniks [14] proposes an anti-naturalistic platform promoting gender and race "abolitionism by multiplication" and advocates for technologies such a gender hacking, open access pharmaceutical 3D printing and DIY-HRT as means of liberation. These potential cultural changes will impact the urban spaces as well, reshaping the ideas of domestic and public spaces, reallocating gendered spaces, hacking the spaces of production. How will the housing of the future be modified by these social changes? What kind of new social articulation will inscribe themselves in the territory?

While the idea is certainly intriguing, transhumanism has its flaws, recognised already by authors who pioneered the movement. For example, Hayles, author of *How We Became Posthuman* [38]," criticised most of the approaches of transhumanism for decontextualising its dimensions and results and for oversimplifying. Moreover, she further emphasises the individualistic approach of both More [60] and Bostrom [6]. Such an approach, she argues, threatens the collectivist enhancement of transhuman communities, and may result in tremendous inequalities induced by body enhancements and leading to even stronger discriminations between disabled and superabled individuals, a point also raised by McNamee & Edwards [57]. Both authors argue that when every individual is free to enhance their body however they want, this would pave the way for an unequal way of living and perceiving life among transhumans. Another major direction of critique to

transhumanism comes from bioethics. Some methods envisioned by transhumanism, such as genetic modifications for enhancing human abilities, raise strong concerns regarding eugenics where the genetically modified and enhanced humans would be seen as superior to others [47]. Moreover, the selection of the properties of humans that will be considered undesirable and eliminated through technology has the potential to bring about discriminating practices. Other critiques to transhumanism include conflicts on the biological definition of human [57] and problematic applications of procreative actions [1]. Transhumanism is at the centre of an ongoing lively debate where both sides have strong arguments to pinpoint its potential and dangers. We acknowledge this duality and share the critiques on the limitations and dangers of transhumanist approaches. For this reason our framework and scenarios clearly lay out and address the possible problematic outcomes of transurban relationships as well as the positive ones.

Last but not least, transhumanism should be understood as only a part of the posthuman horizon. Posthuman thinking [23] urges us to go beyond human-centred design: humans, augmented or not, will not necessarily be the only subjects in transurban cities. The transurban approach, then, should also be a posthuman one, aiming to take into consideration all more-than-human animals and potential other beings (i.e. artificial ones) and their possible interactions and cohabitation [74]. It is important to consider this variety of potential users already in the urban design process, as any solution will likely affect them all [23]. We argue, therefore, that a purely human-centred approach to transurbanism is, *per se*, insufficient [13, 22]. For practical reasons, this approach to transurbanism will be only a first step, and will focus mostly on transhuman citizens. Future research, however, should expand these framework also to other kinds of subjects.

FUTURE CITIES AND SPECULATIVE URBAN DESIGN

In the previous section, we raised questions related to how transhuman technologies will revolutionise the cities of tomorrow. Answering them would allow us to prepare for these changes, the challenges and risks that they bring in terms of design, management, and society. The impact of technology is always unpredictable: we are still struggling to understand how the ICT revolution is affecting our society and politics while new revolutions are already approaching.

These questions, however, cannot be holistically, reliably or realistically answered. Despite the efforts of future studies, most forecasting techniques are highly problematic when applied to societal change. Some approaches tend to be too deterministic or recur to backcasting [40], others have fundamental weaknesses in considering the random nature of the reality and consequent rare occurrences [32] and, in general, they struggle to anticipate the unpredictable and sometimes erratic behaviour of human beings. There is, however, a way to interface with these possible changes: using speculative design [19] and design fiction [75].

These paradigms do not have the pretense of accurately predicting the future, but they solve the issue in a creative way: while we cannot be sure of what the future holds, we can imagine a series of possible futures (more or less likely) and use them as a starting point for a critical reflection on what the future might hold and which possible future is more desirable. This approach also constitutes the core of many transhuman visions [7, 6, 33, 72]: if we can anticipate the future better, or even take part in shaping it, we will be better able to navigate its hurdles and negative ramifications.

Speculative design and design fiction serve two main purposes: they enable us to think about the future, and they are an opportunity to critique current practice [2]. The "pretend" nature of these practices, additionally, allows us to engage in dark design [19], that is, in the creation of dystopian projects that work as cautionary tales. Inventing scary and dysfunctional futures can help us question our decisions today and may prompt us in trying to avoid them. Research indicates that stories and narratives allow to explore emerging fields and progress in the HCI field [4]. Both speculative design and design fiction, have already been used to explore future cities and the practices that they might host [91, 24]. Design fiction, however, is not always unproblematic. It has been pointed out, for example, that it does sometime adhere to a solutionist mentality [62] and often forgets to portray privilege, inequality, social issues or diversities of the population to focus instead on utopian, eternal-growth-driven futures [68, 54].

In order to engage in an effort of speculative design oriented to the transurban environment, however, it is important to recur to the specific methodology and literature of urban design. In this paper, these two paradigms and their out-of-the-box epistemologies, therefore, will be in constant dialogue with urban design. The latter is instrumental in creating better places for people [11] using different methods to understand their expectations and needs [20, 3, 8]. Therefore, understanding potential outcomes of these questions: *what will the cities future look like? and what will the human beings of the future look like?* are critical for urban designers to create better places in the future.

The Transurban Framework, then, aims to mediate between exclusively techno-centric design fictions, and urban design that is attentive to the citizens but technologically agnostic. Thus, it offers strategies and paradigms for understanding and including citizens in the design of the cities (going beyond simple data-collection) to urban designers and stakeholders.

In order to reach this goal we decided to create three *pastiche scenarios* [5]. This specific form of design fiction is based on the creation of narrative texts that focus on the feelings and experiences of the users when confronted with certain objects or situations. In our case, the narratives will revolve around the citizens of three fictional transurban cities and on the effects that the integration of transhuman technologies have on their lives. We believe that this approach is particularly useful when dealing with transurbanism, as it allows to look at the city as a whole, but from the perspective of the individual. Additionally, each of our pastiche scenarios will have two realisations, a utopian and a dystopian one. While reality is often in the middle, the two polarities of each scenario will allow us to assess some of the potential risks and benefits of each technology, and therefore to individuate desirable and undesirable outcomes.

We decided not to accompany our scenarios with visuals, so to allow the readers to form their own image of the fictional cities and to have a personal response to the narrative presented. Similarly to novels, illustrations can offer support to imagination, but tend also to direct it and may endanger the *suspension of disbelief* [71]. We will rely, therefore, on the written word, in the attempt to speak to our readers on a more personal and emotional level.

Our methodology, hence, is based on the creation of pastiche scenarios, drawing from the knowledge and strategies of urban design and combining them with the imaginative approach of design fiction and speculative design. This attempt of application of speculative urban design is multidisciplinary in nature. The background of the authors of this paper is transdisciplinary, including interaction design, human-computer interaction, urban design/studies and semiotics, organisation studies and information systems. More specifically, the first author has a PhD in semiotics and is leading in a project dedicated to urban gamification; the second author obtained a PhD in interaction design and led several projects focusing on playful bodily technologies such as movement-based interaction/games and wearables; the third author is an urban planner who has a master's degree in urban design which focuses on contingency relations established between citizens and space as a result of the daily urban experiences; the fourth author is professor of gamification and has an extensive background in organisations studies and information systems science. This Transdisciplinary approach assists in creating the three pastiche scenarios presented in this paper.

THE TRANSURBAN FRAMEWORK

In order to orient and support our activity of speculative design, we structure it according to a specific framework built around the different dimensions of smart cities and their transhuman citizens.

Defining smart cities is still an ongoing endeavour and there are debates that approach this problem from many distinct sides. Several frameworks defining the changing relationships between citizens and the city with the integration of developing smart city technologies have been proposed in previous studies [25]. For example, the smart city framework developed by Chourabi et.al [12] considers citizens as actors whose lives are affected by technology (ideally entailing an increased quality of life) and who participate in the city through the use of technology. Previously, Giffinger and Haindlmaier [31] identified the "smart people" as one of the six components of the smart city and defined them throughout properties such as "being open to learning". In a more industry-oriented framework, IBM's smart city framework [42], the"people" category focuses instead on citizens' well-being, social inclusion and education. These three frameworks consider "governance/management" as a separate component, along with the physical level of the city which includes buildings, infrastructure, natural environment and transportation. While all these frameworks feature comprehensive explanations of the interrelations between many different aspects of smart cities, none of them investigates conscientiously the urban design process. We believe, instead, that the latter is a critical critical aspects of smart cities for the creation of a human-centred (or transhuman-centred, in our case) framework. This is particularly true in light of current participatory and bottom-up urban design approaches [13].

The creation, planning and design of smart cities have been also investigated and explained in a systematic way by previous studies. One study addressed top-down and bottom-up approaches, along with the planning strategies they introduced, through a case-study [48]. This led them to define co-design and engagement of stakeholders as one of the main steps of smart city planning. Another study characterises the steps of smart city research and practice through Action Design Research principles, again emphasising the importance of participatory approaches to stakeholders and defining it as a form of "Reciprocal Shaping" [51]. Nam and Pardo concluded that a city becomes "smart" only when the advancements in social capital and IT lead directly to an increased quality of life and sustainable growth through mechanisms of participatory governance. Similarly, Gascó-Hernandez emphasized the importance of citizen participation in her analysis of Barcelona Smart City Design, stating that no smart city can involve its citizens only as recipients of its interventions, but it must instead include them as partners able to decide the type of city they want to live in, throughout the phases of design, implementation, and evaluation [30].

Drawing upon the established frameworks on the smart city concept, here we outline a transhuman-centred framework which sheds light on the challenges and possibilities arising from making citizens a living part of the technological infrastructure. From this perspective, citizens are not merely seen as using the technology but as being the technology. In this framework, then, we put transhuman citizens in the centre. On the one hand, because we agree that citizen participation in the making of the city is an essential feature of urban life. On the other hand, because their enhanced capabilities will dramatically affect all the other relations between the different components of transurban framework.

In this framework, we define six major components, three of which represent the smart city dimensions, that we articulate around its design, management and social layers, and three that refer to the enhanced features of transhuman citizens described above, namely physical, cognitive and emotional augmentations.

It is important to notice that the different dimensions of our framework are not rigidly separated. Physical augmentations, for example, can have clear effects on cognition and emotion - and vice versa. While we do not claim any insurmountable separation between them, we believe that these distinctions, although blurred, have indeed an operational value. In other words, they offer useful guidance for reflecting and analysing the possible evolution of transhuman technologies.

Smart City Dimensions

Design Layer: includes the urban design processes of the city considering the participation of citizens, embedded technological infrastructure and interaction design between citizens' enhanced bodies and the city, environmental implications of city design.

Management Layer: refers to all regulations that will dramatically change per existence of transhuman bodies including transportation laws, sustainability policies, public safety, economic decisions and more.

Social Layer: encapsulates social relations among transhuman citizens and their social needs related to city, social inclusion, social relations, activities, well-being, education and communities.

Transhuman Citizen Dimensions

Physical Abilities: include enhanced lifespan and physical abilities (stronger muscles, increased eyesight, hearing etc. and thus enhanced abilities such as running extremely fast without fatigue or jumping immense heights).

Cognitive Abilities: refer to the augmentation of information "processing" abilities, enlarged memory and thought/memory

Table 1. Interactions between Smart Cities and Transhuman Citizens; Opp: Opportunities, Cha: Challenges

		Physical	Cognitive	Emotional
Design	Opp	Radical design availabilities due to the extended vertical and horizontal movement abilities of citizens.	Very-well informed and immediate participation of citizens to the design of the city.	Ability to design places that can induce particular emotions due to the advanced emotion tracking and hormone control techniques and technologies.
	Cha	Creation of new urban design paradigms that will satisfy the enhanced physical needs of transhumans.	Designing stimulating cities that can satisfy the cognitive capabilities and needs of transhuman citizens.	Increased variety of emotional experiences to be pleased by a wide portfolio of newly emerged city-scape designs.
Management	Opp	Individual-level well-being applications due to the continuous health monitoring and autonomous steady treatment systems embedded into the body of citizens.	Immediate and rich knowledge created by citizens about the facilities of the city (infrastructure, governance) which will be communicated instantaneously and used by the governing body. Capability of tracking the state of the city through the internet of citizens with accurate and ample amount of knowledge.	Real time emotional maps that will allow managers to direct their efforts and test the results of their actions regarding safety, tourism and the psychological well-being of the citizens.
	Cha	Management of extremely diverse (and potentially massive) populations in relatively small areas due to the extended lifespan of transhuman citizens.	Responsibility of providing security for the cognitive systems of transhuman citizens. Need for regulations for limiting the access to information, thoughts and information processing of citizens and the protection of thought-data which is not made publicly accessible.	Ethical issues regarding the emotional monitoring of citizens. Need for the rules preventing maps to be used for fostering gentrification of certain areas or making certain demographics feel unwelcome. Regulations for access to maps by 3rd parties.
Social	Opp	Physical extensions and modifications can contribute to create a post-gender and post-race society, where a whole new spectrum of identities can be expressed and experienced.	The increased cognitive abilities and connection to available information and to knowledgeable citizens that will allow transhuman citizens to have opportunities of equal education. Formation of well-educated citizens through access to knowledge that will affect cities' economies in the positive way.	Emotional tracking that will help improve the mental health of the whole society, allowing NGOs and professionals to act efficiently when is needed and to see the impact of their work on the community.
	Cha	Designing inclusive city parts that will be accessible to differently-abled citizens due to their choices of different physical augmentations. If being disabled will not be an issue anymore, being abled in different levels will create complex accessibility issues. Additionally, if the accessibility to implants will be dependent on personal income, wealthier citizens will hold a privileged position in accessing city spaces.	Hindrance of social connection between communities and citizens due to the connected minds, virtual simulations and individual efficiency. Danger of cities being envelopes that encase individual parts rather than communities that may harm the collective identity.	Possibility of discrimination for individual groups of urban areas due to emotional tracking. This might cause further fragmentation of the city spaces while having a negative impact on the mental health of fragile individuals that will be subjected to additional pressure for the social consequences for their feelings.

sharing via city infrastructure providing connectivity and information pooling.

Emotional Abilities: refer to the experience of new emotions resulting from enhanced physical and cognitive abilities. It also refers to advanced systems that might be able to track, record and share these and other emotions, allowing the creation of emotional maps. In the long term, it might include implants able to reduce negative emotions and boost positive ones.

In Table 1, we outlined possible opportunities and challenges related to interaction between these dimensions. The **Cha**llenges and **Opp**ortunities serve as exploratory examples of possible relations, but could be easily extended further. We situate our pastiche scenarios within some of the frames formed by the intersections of these six dimensions, and we articulate their utopian and dystopian realisations according to the risks and challenges we have outlined.

The dimensions that we selected for our framework are those that we deem the most relevant to exemplify how we envision transurban life. Nevertheless the dimensions regrading the smart city could be extended towards concepts such as environmental impact or economic consequences. Similarly, other dimensions of transhuman citizens, e.g. the increased lifespan, could be examined more thoroughly as a dimension. Therefore this, for sure, is not the only way to imagine and understand transurban life, but more of a comprehensive picture for starting the discussion. Similar to our work, most previous smart city frameworks also differ in terms of the dimensions they focus on as indicated by the comprehensive review of Yigitcanlar et al. [90]. Thus, while our work offers a way to analyse cities by focusing on the abilities of (trans)human, future work could and should also continue this exploration and address topics such as sustainability, infrastructure building or economic growth, which will all be affected by transurban applications.

THREE SPECULATIVE PASTICHE SCENARIOS

In this section we elaborate three pastiche scenarios: short narrative first-person recollections about three transurban cities built on our framework called *Zemrude*, *Phyllis* and *Euphemia*, and aiming to highlight some of the critical spots that emerge. We decided to name the cities after Italo Calvino's *Invisible Cities*

[9] in order to reinforce, on the one hand, their fictional character, and on the other hand, the fact that they do have something to say about the real world, about the consequences of the ICT revolution, about (trans)human and (trans)urban nature. While Calvino's work was not a source for the creation of our scenarios, after we started sketching them, we discovered several affinities. We borrowed the names from his book to acknowledge this and to give some poetic depth to our design.

Each city incarnates one of the transhuman citizen's dimensions of our framework. Zemrude's citizens are emotionally augmented, those of Phyllis all have physical augmentations while the cognitive abilities of the inhabitants of Euphemia have been technologically enhanced. Of course, the types of augmentations available in these spheres are many: we selected here some that we deem particularly thought-provoking and that are related to contemporary developments. The emotional city-mapping of Zemrude is a possible evolution of biomapping technologies [64]. The enhanced mobility of Phyllis is an echo of the acrobatic practices of parkour and free running but extended to all the population [87]. The Internet of Citizens (IoC) implemented in Euphemia, finally, is a sort of technological incarnation of the "city speech" theorised by Saskia Sassen [26].

As mentioned, we outlined for every city both utopian and dystopian realisations, so to explore the affordances of the technologies when their impact is stronger. In all these six possible future cities we touch briefly on the design, management and social dimensions, as outlined in our framework.

Zemrude or Drawing emotional maps of cities

In Italo Calvino's *Invisible Cities*, Zemrude is a city that changes according to the mood of the beholder: the emotions appear to stick to it, and there you will find "again each morning the ill-humour of the day before, encrusted at the food of the wall" [9, p.66]. For this reason, we named *Zemrude* our speculative city where the government has implemented a complete emotion-tracking system throughout the whole city. The citizens of Zemrude are all equipped with technologies that measure, in real time, their heartbeat rate, hormone levels and neurotransmitters. These data are then transmitted to a central system that organises them and allow city officials and citizens alike to access them in the form of emotional maps. These maps will allow to visualise the most exciting, fun, picturesque, melancholic or depressed neighbourhoods, to determine the least stressful route to travel in the city, to assess the impact of the weather on the urban mood and so on and so forth. City management is able to use this data to plan activities and interventions, design new buildings and services and evaluate the impact of its own policies. So how is life in Zemrude?

"I lived all my life in **Utopian Zemrude**. I love my city and I want to participate in making it a better place to live in for everyone. For this reason, a few years ago I joined an NGO that, together with city officials, organises "emotional requalification programs" in several neighbourhoods. These programs aim to improve the mood of citizens by reshaping the urban environment. Basically, thanks to the emotional mapping operated by the municipality we are able to identify critical areas, where the *mean-mood* of the citizens reaches critical levels of depression, anxiety or fear. This happens often in neighbourhoods with a significant percentage of low-income households and immigrant residents. While the city officials use this information to decide how to direct their efforts (institution of mental-health centres, economic incentives, actions to reduce noise pollution or traffic), me and other volunteers organise and coordinate grassroot task forces of residents to take part in several activities of urban embellishment and conviviality. Last week we organised an urban game and a series of small, playful manifestations, in a particularly complicated neighbourhood. It was a lot of fun and we had some great feedback from the participants. Most of them recognise that their situation needs structural changes to improve, but they all stressed the importance of having some occasions to just make the city happy and joyous. The effort was quite demanding, but when I checked the emotional map of Zemrude and saw the difference we had made (and the combination of the emotional data with the increase of my organic hormone level) the satisfaction was great! I heard that urban designers are starting to use the feedback they gather from the emotional responses of the citizens to outline some basic principles of "urban emotional design". I reckon that soon they might be able to realise relaxing highways or more exciting touristic areas. Nevertheless, I believe that our grassroot interventions will always be needed: there is nothing like a sense of community to cheer up a city!"

"I moved to **Dystopian Zemrude** three years ago as I found a job there. I was unemployed for almost a year before and that, joined with the stress of moving out, had a very bad impact on my emotional state. This made looking for an apartment to rent extremely difficult. The estate market has been deeply influenced by emotional mapping. Landlords and companies strive to keep the "emotional mean" of several areas as high as possible and have no desire to rent an apartment to someone like me, with a history of depression. Legally they are not allowed to ask for an emotional resume, but most agencies do it anyway. I had a few interviews too, and I tried to look as cheerful and enthusiastic as possible, but the fact that I am quite introverted did not really help. Thanks to this form of emotional gentrification, after two weeks of attempts, I finally ended up in a *depressionhood*, in the outskirts of the city. The apartment is nice but living here is quite tough. Whoever is able to afford it avoids coming around here, and the "emotional mean" is one of the lowest of the city. Poverty and mental illness feed each other, and I am often afraid when I go out. Not that there would be much to do, companies try to profit of this sort of situation and mostly offer junk food and evasion. I have never seen so many ads for antidepressants in my life. I guess it works: most of the people here seems not to care, gobbling pills and going from a distraction to another. That does not work for me. And living here has already had a strong impact on my life. Not only on my mood, that is always low, but also on my finances. Thanks to my job I am still able to have health insurance, but their fares sky-rocked simply due to my address. Lately my boss has started to check up with me more and more often. I heard that the new mayor wants to increase the emotional prestige of the city centre, and that companies with offices there are pressured to screen and mob negative employees."

Phyllis or Transurban mobility

Calvino describes Phyllis as beautiful cities full of bridges, doors and paths. The city, however, becomes soon insignificant for its inhabitants, it becomes "a space in which routes are drawn between points suspended in the void" [9, p.90]. We named *Phyllis* a city where transhuman physical abilities allow citizens to move freely in the urban areas. Physical disabilities are a thing

of the past, and the denizens of Phyllis are able to run, jump, climb (and in some cases even fly!) safely to their destination, regardless of their age or conditions. Liberated from most of the constraints of traditional logistics, the city has been able to expand in all directions, while most of the space previously allotted to infrastructures related to mobility (roads, rails, parking lots bike lanes) has become available for new projects.

"Yesterday my kids came home all excited. They are twelve and ten years old and they go to the same school. As we do not live far, they generally like to zoom a few kilometers and get back home on their own. At their age kids love to test their new implants and use them to explore the city spaces and the many ways you can move through them. **Utopian Phyllis**, from that perspective, is a perfect place: the elegant tridimensional web of infrastructure that overhangs the old city allows us to move seamlessly – and enjoy great views while doing it. This new kind of mobility, at the same time, had a strong impact on safety: the old ghettos disappeared when citizens started to be able to move freely thought the urban spaces. Anyway, yesterday my kids where particularly excited because they just made a long detour to come home and went down in the streets of the old city. Once we got rid of the cars and of the old means of transportation, most streets and parking lots were replaced with canals and urban forests. My kids told me that they explored a large strip of vegetation that was encircling the whole city – my guess is that they found the ringway! – and were delighted by the rich wildlife they found there. While it is not rare to see hares or foxes also in the forests in our block, they told me they were able to see much bigger animals, like a herd of deer and a solitary elk. They looked so happy we decided to go there for a stroll in the weekend."

"Sometimes I feel a bit guilty when I have to go through the city center. When I have to crawl between the buildings surrounded by my bodyguards, and I wonder how people can really live like this. I remember distinctively the thrill when **Dystopian Phyllis** was declared the first car-free city in our country: such an incredible opportunity for real-estate! Suddenly half of the city's land that had been used for cars and trucks was without purpose, free to be purchased. Some groups of citizens did push to keep it public, but they did not take into consideration the economic consequences that the municipality was suffering for banning vehicles. The city needed money fast and I was among those quick and wealthy enough to profit from it. It was a golden age for building companies. The old transportation infrastructures were quickly and completely occupied with new housing, retail, warehouses and offices. In the poorest neighborhoods someone occupied the streets illegally, creating a few slums. The city, however, was happy to privatize those lands. And I bought many for a very good price. In a handful of years, the density of the city almost doubled – near the city center it is almost intolerable. Most of the industrial production had already been outsourced anyway, so as long as there is space for the citizens to crawl and for drones to deliver goods the city works, and the economy is happy. Nevertheless, when I happen to go through an anthill neighborhood, I do sometimes feel a bit guilty, as I said. At the same time, I know that it is how things go. If it wasn't me, someone else would have profited from the situation. I'm not really to blame."

Euphemia or The Internet of Citizens

Euphemia is, according to Calvino, a city where memory is exchanged, where "memory is traded at every solstice and at every equinox" [9, p.36]. *Euphemia*, in our scenario, is a city where citizens are directly and constantly connected to the Web and are able to store and retrieve memory and information. In Euphemia, it is enough to look at a building to be able to gather all sorts of information, historical, architectonical, legal, around it, it is enough to think about a place in order to know how to reach it. This sort of Internet of Citizens allows the residents of the city to share everything they want with each other, to leave virtual traces in the urban environment, to make available to all their ratings and comments about everything they see.

"Last summer I went to visit a couple of friends in **Utopian Euphemia**. They have been pestering me about going to visit them for a long time: they are really in love with their city. I spent there only a weekend, but I have to confess that now I understand why. At a first sight, the neighborhood they live in is quite anonymous. It is nice, and clean, has a few parks, but nothing exceptional or surprising. That is, until you tune your implant with the city's IoC service. The first impact is the incredible amount of information that other citizens are sharing everywhere: thoughts, memories, comments, art, memes and much more. Every tree in the parks, every lamp post, every window has some sort of story and it is willing to tell it to you. It is difficult to feel alone, there: you tune in and you become part of a *place*. My friends explained me later that they use this system also to have a continuous dialogue with the municipality: the community submits well informed projects as in a sort of cooperative game to imagine the best neighborhood possible. The city government, then, receives these proposals and acts accordingly rapid and incisive actions, that gain immediate feedback from the citizens. They called it a *loop of urban improvement* and said that it makes the city adaptable to the changing needs and expectations of the population. It was easy to tell they are very proud to be part of it!"

"I moved away from **Dystopian Euphemia** almost one year ago. It was a difficult decision: I was born there, and it is indeed a splendid city, I wouldn't have minded staying there. The situation with tourism, however, became unsustainable. To be clear: there were always a lot of tourists coming to Dystopian Euphemia, and while it was good for the city economy, it made the life of the inhabitants harder. The final blow, however, was the hijacking of the IoC for touristic purposes. To compete with other capitals of global tourism, the municipality started an aggressive campaign of rebranding. The city became flamboyant, a baroque accumulation of content, a theme-park on steroids. The overstimulated visitors and tourists wander around constantly flooded with new stimuli to make up for their brief attention span. The municipality put a lot of effort in making some zones as attractive, entertaining and interactive as possible. So, these new hyper-stimulating neighborhoods are now populated mostly by people that do not live there. Citizens like me, fleeing the outroar, moved first to dormitory residential areas, and now those who can afford it leave the city altogether. The community I grew up with, has been completely eradicated: Euphemia in the end stopped being a city and become a mere conglomerate of buildings."

IMPLICATIONS FOR THE PRESENT

In the previous section we borrowed the names of the cities from three of Calvino's *Invisible Cities*. In his book, the Italian author describes in total 55 of them, and, reasoning on transurbanism, we could probably imagine just as many, and probably more, scenarios for future transurban cities. The three we have outlined, however, show how radical could be the impact of transhuman technologies on the urban fabric, strong enough to reshape it or to tear it off completely. The same technologies can offer possibilities for building cohesive communities and healthy environments or to shatter the urban space in alienated citizens and dysfunctional spaces. The cities of tomorrow are not likely to be *Zemrude*, *Phyllis* or *Euphemia*, they will probably be a mix of the three, with many additional elements that we, or anyone else, could hardly even imagine at current time. So, what can this study about the cities of tomorrow tell us about today?

Our framework shows how dramatic change in the physical, cognitive and emotional abilities of citizens will alter the scale of the city and make its boundaries invisible, as the physical and the cognitive reach of citizens will expand beyond what we today understand as the "city". To design the cities of the future, we need then a radical change of paradigm, we need to think beyond cities and beyond human. On the other hand, to understand how small tendencies in today's metropolises, such as citizens starting to alter their faces with makeup or jewellery to avoid facial recognition and evade the smart city mechanisms that are digitizing public spaces or such as private companies envisioning and advertising personal underground transportation systems, we need to be able to imagine a transurban design. This is a design mindset specifically formed around highly mobile citizens, around citizens whose minds and thoughts are integrated with the city infrastructure, around inhabitants that might be able to reshape their environment through their emotions. It allows us to put forth novel dimensions of city design for transhumans, without forgetting the very human social and cultural basis necessary for a city to thrive. The physical and cognitive-design intersections of our framework propose generative interpretations that facilitate thinking about technologies that are already becoming part of our daily life. Thus, the challenges and opportunities outlined in our framework highlight areas that might be considered beyond cities but will soon be part of them. The transurban framework is meant to "inform the present", that is to provide useful insight to today's HCI and smart city research. In particular, the scenarios addressed the critical points of the contemporary crises investing the urban spaces that we have mentioned in the beginning of this paper. Utopian Zemrude mentioned migration and its dystopian version dealt with gentrification, Phyllis mentions ghettos in its utopian version and the outsourcing of industrial production in the dystopian one, Utopian Euphemia addresses directly the loss and recreation of a sense of place and dystopian Euphemia draws from globalisation. These scenarios aim to guide the reflection on the impact of transhuman technology on cities. To exemplify it, we will now briefly walk through the different dimensions of the framework and their implications.

First, imagining transurban mobility helps us to put into focus the current physical augmentations of citizens. This will help us to forecast, in some measure, their possible impact on city life and urban design. The intersection of the framework focusing on physical augmentations in relation with the design dimension, for example, offers us interesting insights. Although today's citizens do not have the transportation range we envisioned in our scenario, mobility is a key element of urban life and a rarely unproblematic one. Transportation is often affected by inequality, for example, and tends to perpetuate it [65]. The Chilean protests of 2019-20, due to a diverse set of socio-political factors, were triggered by the raise of the subway fares in Santiago, which became unsustainable for many. Issues related to the sustainability of urban transportation, and its impact on air quality, are also widely debated. The profound changes emerging from transurban transportation, then, will have an impact on all these key issues.

Some of this disruption is already in its beginning: the diffusion of app-based personal mobility devices (PMD) reshaped dramatically the ways citizens move through and experience the urban spaces [82]. Today sidewalks and bicycle lanes are filled with electric scooters or other PMDs, that provide ludic means to commute and travel, but also present several safety risks [45]. If we consider the vertical dimension, although easily available technologies still do not allow citizens to "fly", physical flying proxies – the drones – are being increasingly used to acquire a bird-eye perspective on the city. Moreover, personal action cams have become embedded in practices such as parkour, rendering parts of cities that were traditionally inaccessible to citizens suddenly to their reach. Previous research on these topics focused on the societal impacts of such mobility technologies [45] or on the privacy breaches originated by drone use [55], underlining the risks raised by an indiscriminate adoption of such technologies. Nevertheless, implications of these technologies on the use and shape of cities are underexplored and we still lack urban design guidelines focusing on how citizens' experience is being changed by them. *How will the urban spaces liberated by the current traffic needs be repurposed? Will it be used for public projects, maybe benefiting the whole community but requiring significant investment? Or, following current trends, will it be privatized and exploited, effectively reducing public spaces to a minimum? Furthermore, in an age, in which a top-down gaze upon the city is increasingly available via flying proxies, how should designers consider this dimension of cityscapes that were inaccessible to citizens before? Will verticality, generally used to satisfy the requirements for population density, become a resource for city-making? Can this new enhanced reach bring about the danger of turning buildings' walls into advertisement boards? Or can it be considered as a playground and an extended design surface where designers can creatively play?*

Second, the intersection between the management dimension of smart cities and cognitive augmentation challenged us to imagine a city that is surrounded by a cognitive digital infrastructure. This could lead to a city that can be co-created thanks to telepathic crowd-sourced e-participation that keeps citizen in continuous contact with the managers and policy makers of the city. Alternatively, it could become a new level for exploitative communication, to use for advertisement, for business or touristic purposes or a new way to collect big data about the citizens and their behaviour. The key question, therefore, is who will be allowed to 'write' on this layer and who will have access and control over these data. In any case, transhumans will become non-stop participators in the urban management: the very knowledge they produce in their daily lives becomes a resource for the city itself. Such a collection of knowledge would go far

beyond what the big data paradigm is able to grasp: the pool of thoughts from the citizens would be already contextualised, conveyed with all the indices and the depth of human cognition.

Therefore, today's technologies and applications which seek to collect data from (more or less willing) citizens or to involve them in the city design through digital processes could take inspiration from this continuous feed of information and feedback - and learn to be cautious about it. For example, the Digital Twin of City of Atlanta [59] already creates a virtual environment where citizens can engage with the city and influence decision-making about the city. However, it is still a single-layered and temporary system, that attempts to "understand" the citizens only in specific contexts, moments or situations. This sort of system can be evolved towards analysing a complex web of interactions between citizens, infrastructures and the built environment through 'Internet of Things and Citizens' technologies in order to provide a well-grounded context for decision-making. At the same time, tracking strategies such as those of the Chinese Social Credit System, explicitly designed to follow closely every move of their citizens and profiling them could greatly benefit from transurban technologies finding new ways to invade their privacy and enforce surveillance. In our framework, with the capability of transhuman technologies, it might be possible to enable citizens every thought and even feeling without disturbing their city experience. In the current state, *what data administrations can collect from citizens continuously to make them part of the decision-making not only in specific times such as elections or crisis moments but all the time? Who will collect the data and handle it? What are the limits of monitoring actions of citizens without breaching ethical boundaries? What kinds of interfaces should be created to provide seamless, engaging and continuous participation? What regulations are needed to prevent harmful practices that might emerge as a result of continuous data collection?*

Third, when it comes to the intersection between emotional augmentations and the social dimension of smart cities, we decided to emphasise how emotional enhancements of transhumans could help building a better society with improved social cohesion and individual well-being, if handled in a certain way, but could also drive further social discrimination, exclusion and marginalisation of people and communities. Currently, emotional-social technologies in HCI are widely studied: for example, the work produced by the Social Emotional Technology Lab at the University of California, Santa Cruz has been focusing on how technologies can facilitate social and emotional connection and well-being [15, 84]. Another notable example is Katherine Isbister's call for the Suprahuman [44], where she describes Sturgeon's novel *More than Human* [77] and its depiction of a human group consciousness and wonders *"how can technology help to build webs of connection and coordination and co-action between human beings who are physically together?"* In fact, in the current state we can see the proliferation of different products that would promise to regulate the mental state of users through aggregating data collected through brain-signals [43] or respiratory patterns [81]. Still, those products are individualistic, and collective uses are under-explored. *In this direction, how can we use these technologies for improving the sense of community and cohesion? How can we avoid implementations of these technologies that lead to discrimination, isolation or exploitation? Can these emotional technologies be used for collective well-being of a society? What can we learn from each other's quantified mind patterns? Can those technologies, when we come together as people and bring our minds together, can render us more than human?*

We examined here the in-depth implications of three of the nine intersections of the transurban framework – namely physical-design, cognitive-management and emotional-social. For each intersection, we have discussed the current technologies that are related to those dimensions and directed questions to today's HCI research, which are currently under-explored, but are rapidly becoming relevant for the near future. We firmly believe that our framework and our pastiche scenarios can be a way to emerge applications and implications for today's HCI research and that more relevant questions could and should be generated by closely examining the other dimensions pointed out by transubranism framework.

CONCLUSION

In this paper, we created a framework that forms a bridge between enhanced transhuman abilities and smart city layers. Particularly we focused on the enhanced physical, cognitive and emotional abilities of transhumans while taking design, management and social layers in terms of smart cities. We depicted the relations proposed by the framework with three pastiche design scenarios, namely cities of Zemrude, Phyllis and Euphemia, which highlight both the most optimistic outcomes and the darkest consequences to clearly emphasize opportunities and challenges that will emerge as a result of transhuman technologies. We then examined the implications of these scenarios on today's studies concerning smart cities and human-computer interaction by directing inspirational and critical questions emerged from our analysis.

We firmly believe that, this paper will allow smart city stakeholders and urban designers to envision and engage with the transhuman technologies of tomorrow so to help them using these technologies to shape smart, sustainable and humane cities. Although our framework and scenarios refer to realities that will only be achieved with advanced technologies, they also shed light on the near future, where contemporary technologies (not necessarily embedded into our bodies) will rapidly and radically change how citizens behave, move, participate and experience the city. Therefore, introducing the transurban framework does not only inform scholars of the far-future, but it offers inspiration and critical visions to the designers, managers and the researchers of today's (or the near future's) smart cities.

As previously stated, this framework aims to be a first step on transurban research. Future work should focus on the other six intersections of the framework as well as on extending the framework beyond transhuman citizens so to involve other posthuman and more-than-human entities.

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